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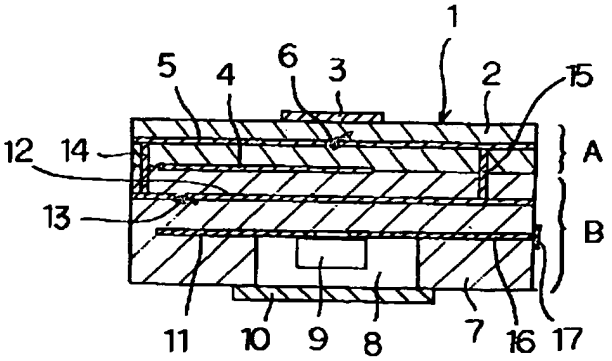
(54)【発明の名称】　高周波用パッケージ

(57)【要約】
【課題】アンテナ素子と高周波デバイスとを具備し、コンパクトでしかも量産が可能なマイクロ波またはミリ波等の高周波を用いたシステムに好適に使用可能な高周波用パッケージを提供する。
【解決手段】第１の誘電体基板２にアンテナ素子３とアンテナ素子３に給電するための高周波線路４とを形成したアンテナ回路基板Ａと、第２の誘電体基板７の一部にキャビティ８を形成し、キャビティ８内に高周波デバイス９を収納し、且つ高周波デバイス９に信号を伝達するための伝送線路１１を形成した高周波デバイス回路基板Ｂとを具備するとともに、アンテナ回路基板Ａと高周波デバイス回路基板Ｂとを積層一体化するとともに、アンテナ回路基板Ａの高周波線路４と、高周波デバイス回路基板Ｂの伝送線路１１とを電磁結合により接続する。



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【特許請求の範囲】
【請求項１】第１の誘電体基板にアンテナ素子と該アンテナ素子に給電するための高周波線路とを形成したアンテナ回路基板と、第２の誘電体基板の一部にキャビティを形成し、該キャビティ内に高周波デバイスを収納し、且つ該高周波デバイスに信号を伝達するための伝送線路を形成した高周波デバイス回路基板とを積層一体化するとともに、前記アンテナ回路基板の高周波線路と、前記高周波デバイス回路基板の伝送線路とを電磁結合により接続したことを特徴とする高周波用パッケージ。
【請求項２】前記アンテナ回路基板が、前記高周波デバイス回路基板における前記キャビティを形成するための蓋体である請求項１記載の高周波用パッケージ。
【請求項３】前記第１の誘電体基板の比誘電率が２～１０、前記第２の誘電体基板の比誘電率が５～５０であることを特徴とする請求項１または請求項２記載の高周波用パッケージ。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、高周波、特にマイクロ波またはミリ波用デバイスを収納するとともに、アンテナ回路を具備したパッケージに関するものである。
【０００２】
【従来技術】近年に至り、マイクロ波及びミリ波を利用した通信システムの開発等が盛んに行われ、それらの機器に使用される高周波用デバイスの開発が進められつつある。
【０００３】マイクロ波及びミリ波は、広帯域、高分解能、短波長等の特性を有することで知られている。これらの特徴は、大容量通信、高速データ伝送、機器の小型軽量化が可能であると同時に、他の通信システムへの干渉性が小さい等のメリットを有することから、従来より、ＩＤカードシステム、無線ＬＡＮ、車載レーダ等のシステムへの利用が盛んに開発されている。
【０００４】このようなシステムは、通常、アンテナ、高周波発振器、増幅器等の高周波デバイス、高周波デバイスを封止するパッケージ、アンテナと高周波デバイス、あるいは高周波デバイス同士を接続する伝送線路から構成されている。
【０００５】しかし、一般的に高周波デバイス自体の出力が弱いこと及び伝送線路における損失が大きいことが問題として取り上げられている。特に、アンテナと高周波デバイス間の伝送損失を低減するために伝送線路として、従来より伝送損失の少ない導波管や同軸ケーブルが用いられている。
【０００６】
【発明が解決しようとする課題】しかしながら、従来アンテナと高周波デバイスとは別体で設けられており、これらの素子間を導波管や同軸ケーブルにより接続する

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り、また、量産にも適さないという問題点がある。
【０００７】一方、導波管や同軸ケーブルに換わる伝送線路として、マイクロストリップ線路、コプレーナウエイブガイド等が用いられているが、単位長さ当りの伝送損失が導波管や同軸ケーブルに比べて大きいという欠点を有するために、容易には用いることができないのが現状であった。
【０００８】従って、本発明は、このような状況を鑑み、アンテナ素子と高周波デバイスとを具備し、コンパクトでしかも量産が可能なマイクロ波またはミリ波等の高周波を用いたシステムに好適に使用可能な高周波用パッケージを提供することを目的とするものである。
【０００９】
【課題を解決するための手段】本発明者らは、このような課題に対して検討を重ねた結果、高周波デバイスとアンテナをできるだけ近接して一体化して配置し、これらをマイクロストリップ線路やコプレーナウエイブガイド等により接続される伝送線路の長さを短くすることにより、伝送損失を極力低減できることを見出し本発明に至った。
【００１０】即ち、本発明の高周波用パッケージは、第１の誘電体基板にアンテナ素子と該アンテナ素子に給電するための高周波線路とが形成されたアンテナ回路基板と、第２の誘電体基板の一部にキャビティが形成され、該キャビティ内に高周波デバイスが収納され、且つ該高周波デバイスに信号を伝達するための伝送線路が形成された高周波デバイス回路基板とを積層一体化するとともに、前記アンテナ回路基板の高周波線路と、前記高周波デバイス回路基板の伝送線路とを電磁結合により接続したことを特徴とするものである。
【００１１】また、前記アンテナ回路基板は、前記高周波デバイス回路基板における前記キャビティを形成するための蓋体であってもよく、さらに、前記第１の誘電体基板の比誘電率と第２の誘電体基板の比誘電率とが異なることが望ましい。
【００１２】
【発明の実施の形態】本発明の高周波用パッケージの構造を図面をもとに説明する。図１は、本発明の高周波用パッケージの一例を示す断面図である。図１において、高周波用パッケージ１は、アンテナ回路基板Ａと、高周波デバイス回路基板Ｂにより構成される。アンテナ回路基板Ａにおいては、第１の誘電体基板２の表面に平面型のアンテナ素子３が形成されており、誘電体基板２のアンテナ素子３形成面の反対側の面には、アンテナ素子３に給電するための高周波線路４（以下、給電線路という。）が形成されている。また、誘電体基板２の内部には、ほぼ基板内全面にグランド層５が形成され、このグランド層５のアンテナ素子３と対向する位置にスロット６が形成されている。このようなアンテナ回路基板Ａに

を介して給電線路４と電磁的に結合されて電磁波が伝達される。

【００１３】一方、高周波デバイス回路基板Ｂは、第２の誘電体基板７の一部にキャビティ８が形成され、キャビティ８内には高周波デバイス９が収納され、蓋体１０により気密に封止されている。また、高周波デバイス９は、第２の誘電体基板７に形成された伝送線路１１と電気的に接続されており、高周波デバイス９には伝送線路１１を通じて信号が伝達される。また、誘電体基板７内にも、全面にグランド層１２が形成されている。

【００１４】また図１によれば、上記のアンテナ回路基板Ａの給電線路４形成面と、高周波デバイス回路基板Ｂの高周波デバイス９形成面の背面同志で積層されて一体化されている。そして、アンテナ回路基板Ａの給電線路４と、高周波デバイス回路基板Ｂの伝送線路１１の間には、全面にグランド層１２が形成され、給電線路４と伝送線路１１とが対向する位置において、グランド層１２にスロット１３が形成され、このスロット１３を介して、給電線路４と伝送線路１１とは電磁結合されている。

【００１５】また、アンテナ回路基板Ａ内のグランド層５と、高周波デバイス回路基板Ｂのグランド層１２とは、できるだけ多くのバイアホール１４、１５等により電気的に接続することがグランド層の共振現象を抑える点で望ましい。

【００１６】このように、アンテナ回路基板Ａにおけるアンテナ素子３と給電線路４、および高周波デバイス回路基板Ｂにおける伝送線路１１と、給電線路４とは、いずれも上述したようにグランド層５、１２に形成されたスロット６、１３を介して電磁結合されているが、このうち、伝送線路１１と、給電線路４との電磁結合構造を図２に示した。伝送線路１１と給電線路４とは同一のインピーダンスになるように形成され、それらの端部同士が平面的にみて伝送信号の波長の１／４の長さ相当で重複するように配置されている。そして、その重複部分のグランド層において、幅が線路の幅とほぼ同一幅のスロット１３が形成される。また、このスロットの長さは信号波長の１／２の長さに形成されている。

【００１７】また、アンテナ素子３と給電線路４とも図２と同様に配置して形成することにより、電磁結合されている。

【００１８】図１の構成によれば、アンテナ素子３で受信した電磁波による信号は、スロット６を介して給電線路４に伝達され、さらに給電線路４と電磁的に結合された伝送線路１１に伝達され、最終的に高周波デバイス９に伝達される。なお、高周波デバイス９において所定の信号処理を行なった後、伝送線路１６を通して外部接続端子１７から出力される。

【００１９】図３は、本発明の高周波用パッケージの他同一機能部については同一の符号を付した。かかる実施例によれば、アンテナ回路基板Ａを高周波デバイス回路基板Ｂにおけるキャビティ８を形成するための蓋体（１０）として形成することにより、パッケージ全体の部品数を減少させることができる。また、かかる構成によれば、高周波デバイス９にヒートシンク１８を接合して高周波デバイス９から発生した熱を効率的に放熱させることができるために、デバイスの加熱による誤動作を防止しパッケージとしての機能の信頼性をさらに高めることができる。

【００２０】通常、アンテナ回路において、アンテナ素子３が図１、３のようなパッチアンテナの場合、アンテナ回路のＱ値は第１の誘電体基板の比誘電率に比例して大きくなり、誘電体基板の厚さｄに反比例して小さくなる性質がある。このＱ値が小さくなると、指向性が乱れるためＱ値は大きい方がよい。ただし、Ｑ値が大きすぎると周波数帯域が狭くなってしまう。ここで、Ｑ値を大きくするために、誘電体基板の誘電率をあまり大きくすると、空気の誘電率との差が大きくなるため、電磁波は、誘電体基板表面を伝播しやすくなり、アンテナ面に垂直な方向の空間に放射されにくくなる。これに対して、放射効率は、誘電率が低く、誘電体基板の厚さｄが大きい程、大きくなる傾向にある。

【００２１】従って、このような観点から、本発明においては、アンテナ回路基板Ａにおける第１の誘電体基板２の比誘電率が２～１０が適当であり、また誘電体基板の厚み（図１におけるパッチアンテナ３からスロット６までの距離）も０．０３λ_0～０．０６λ_0（λ_0は真空中の波長）が適当である。つまり、比誘電率が２より低いか、厚みが０．０６λ_0より厚いとＱ値が小さくなり、比誘電率が１０より大きいか、または厚みが０．０３λ_0より薄いと、放射効率が小さくなる。

【００２２】一方、高周波デバイス９と接続される伝送線路１１や伝送線路１６の線幅は、５０～３００μｍが適当である。これは、線幅を５０μｍより小さくすると、印刷技術や製造時の歩留り等から信頼性の高い線路を形成するのが難しく、３００μｍを越えると、回路自体が大きくなってしまうためである。このため、高周波デバイス回路における第２の誘電体基板７の比誘電率は、５～５０が適当である。例えば、マイクロストリップ線路の場合、比誘電率が５未満のとき、特性インピーダンスを５０Ωにするには、線路幅を３００μｍより大きくするか、又は誘電体厚みを１８０μｍより小さくしなければならない。前者の場合は回路自体が大きくなり、また、後者の場合はテープ多層技術を用いて量産するには薄すぎて適当でない。

【００２３】他方、比誘電率が５０を越えると、特性インピーダンスを５０Ωにするには、線路幅を５０μｍより小さくするか、又は誘電体厚みを７００μｍより大き

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路を形成することが難しく、また後者の場合には、パッケージそのものが全体的に厚くなり、適当でないためである。

【００２４】図１および図３の実施例によれば、アンテナ回路基板Ａにおける誘電体基板２は、上記観点から例えば、アルミナセラミックス、ガラスセラミックス、窒化アルミニウムセラミックス等の材質から構成され、アンテナ素子３、給電線路４、グランド層５は、Ｗ、Ｍｏ、Ｃｕ、Ａｕ、Ａｇ等の導体材料により、周知の多層技術、例えば、誘電体基板２をガラスセラミックス、給電線路４等を銅導体により構成する場合、誘電体基板を構成するガラスセラミック成形体の表面に銅導体ペーストを所定位置に印刷して積層した後、同時焼成することにより形成することができる。

【００２５】一方、高周波デバイス回路基板Ｂも、上記の観点から誘電体基板７を第１の誘電体基板２と同様の材質、伝送線路１２やグランド層１６を給電線路４等の同様の導体により構成することができる。この場合もアンテナ回路基板Ａと同様な多層化技術により形成すればよい。その後、誘電体基板２のキャビティ内に高周波デバイス９をエポキシ樹脂、ハンダまたはＡｕ－Ｓｉ合金等の接着剤により設置する。

【００２６】なお、前記アンテナ回路基板Ａと高周波デバイス回路基板Ｂとは、Ａｕ－Ｓｉ合金や、Ａｕ－Ｓｎ合金等の所望の接着剤により接合一体化することもできるが、望ましくは、それぞれ誘電体基板と基板内の導体と同時焼成する場合、予め焼成前の成形体を積層一体化した後、アンテナ回路基板Ａと高周波デバイス回路基板Ｂとを同時焼成して形成することが望ましい。

【００２７】なお、図１および図３の実施例によれば、アンテナ素子３はいずれもパッチアンテナであるが、もちろんアレー化して指向性等を付与してもよい。また、高周波デバイス９には様々な機能を具備することが可能であるが、例えば、図４の構成のように、少なくとも１つの周波数変換器１９、高周波発振器２０を含み、望ましくは低雑音増幅器２１や増幅器２２を具備し、パッケージの外部接続端子１７から出力される信号は、アンテナ素子３で受信または放射される信号周波数よりも低い周波数におとし、伝送損失を小さくすることが望ましい。

【００２８】

【発明の効果】以上説明した通り、本発明の高周波用パッケージによれば、アンテナ回路基板と高周波デバイス回路基板とを一体化して接続する線路を短縮化することができるために線路での損失を最小限とすることができるために、アンテナ回路を具備しながらも小型でしかも量産が可能なマイクロ波またはミリ波等の高周波を用いたシステムに適用できる高周波用パッケージが得られる。

【図面の簡単な説明】

【図１】本発明の高周波用パッケージの基本的構造の一実施例を示す断面図である。

【図２】図１のパッケージにおける電磁結合構造を説明するための図であり、（ａ）は平面図、（ｂ）は断面図である。

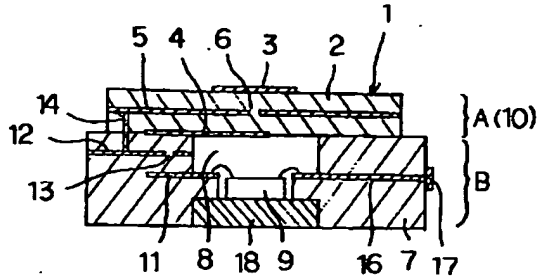
【図３】本発明の高周波用パッケージの基本的構造の他の実施例を示す断面図である。

【図４】本発明の高周波用パッケージに収納する高周波デバイスの一例を示すブロック図である。

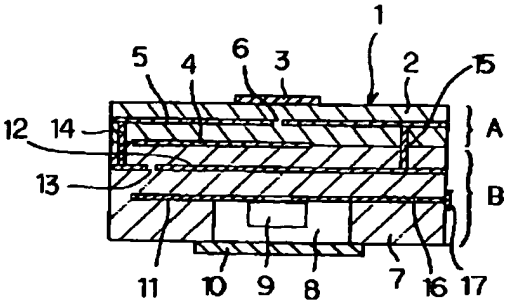
【符号の説明】

１　高周波用パッケージ
Ａ　アンテナ回路基板
Ｂ　高周波デバイス回路基板
２　第１の誘電体基板
３　アンテナ素子
４　高周波線路
５　グランド層
６　スロット
７　第２の誘電体基板
８　キャビティ
９　高周波デバイス
１０　蓋体
１１　伝送線路
１２　グランド層
１３　スロット
１４，１５　バイアホール
１６　伝送線路
１７　外部接続端子

【図３】



【図1】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5
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A
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B
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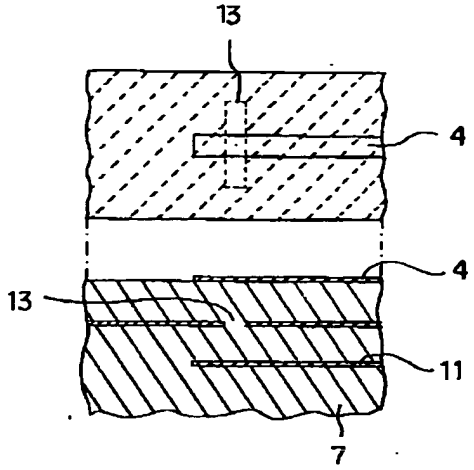
17

【図2】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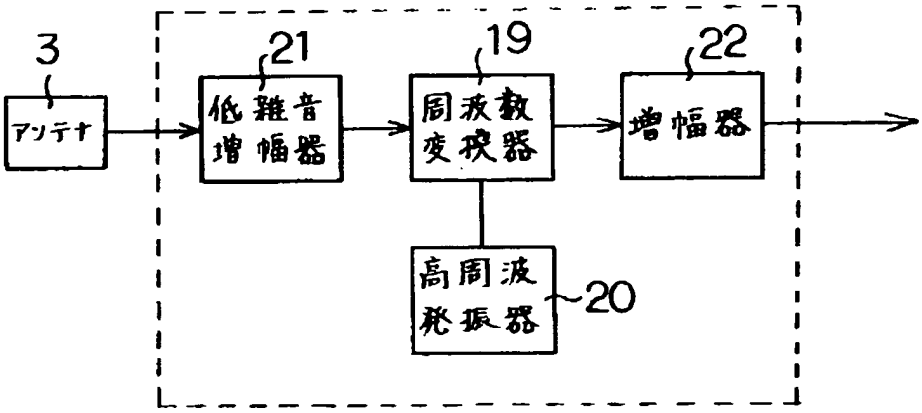
11
7

【図4】


3
アンテナ
21
低雑音増幅器
19
周波数変換器
22
増幅器
高周波発振器
20

EUROPEAN PATENT OFFICE

Patent Abstracts of Japan

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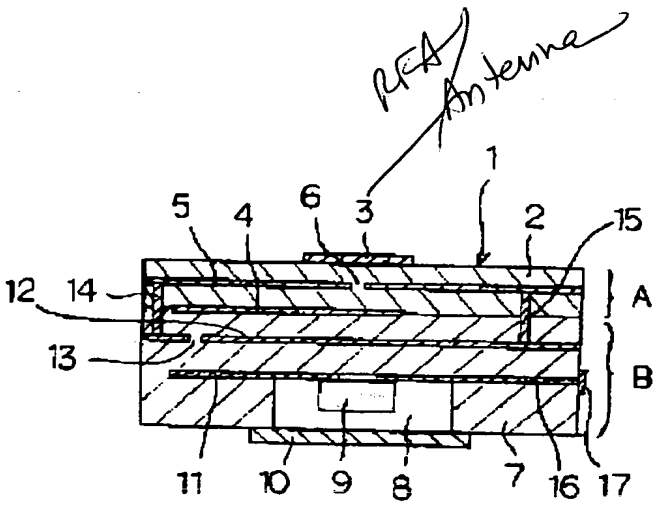
APPLICANT : KYOCERA CORP;

INVENTOR : TAKENOSHITA TAKESHI;

INT.CL. : H01L 25/00 H01L 23/04

TITLE : HIGH-FREQUENCY PACKAGE



ABSTRACT : PROBLEM TO BE SOLVED: To provide a high-frequency package which is equipped with an antenna element and a high-frequency device, compact in structure, suitable for massproduction, and suitably applicable to a system of high-frequency such as microwave or millimeter wave.

SOLUTION: An antenna circuit board A is composed of an antenna element 3, a high-frequency line 4 which feeds an electric power to the antenna element 3, and a first dielectric board 2 where the high-frequency line 4 and the antenna element 3 are provided, and a high-frequency device circuit board B is composed of a second dielectric board 7 where a cavity 8 is provided, a high-frequency device 9 housed in the cavity 8, and a transmission line 11 which transmits signal to the high-frequency device 9, and a high-frequency package is equipped with the boards A and B, wherein the boards A and B are joined into one piece, and the high-frequency line 4 of the antenna circuit board A and the transmission line 11 of the high-frequency device circuit board B are connected together by electromagnetic coupling.

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The antenna-circuit substrate which formed the RF track for supplying electric power to an antenna element and this antenna element in the 1st dielectric substrate, While the laminating unification of the RF device circuit board in which the transmission line for forming a mold cavity in a part of 2nd dielectric substrate, and containing a RF device in this mold cavity, and transmitting a signal to this RF device was formed is carried out The package for RFs characterized by connecting the RF track of the aforementioned antenna-circuit substrate, and the transmission line of the aforementioned RF device circuit board by the electromagnetic coupling.
[Claim 2] The package for RFs according to claim 1 which is a lid for the aforementioned antenna-circuit substrate forming the aforementioned mold cavity in the aforementioned RF device circuit board.
[Claim 3] The package for RFs according to claim 1 or 2 in which the specific inductive capacity of the dielectric substrate of the above 1st considers that the specific inductive capacity of 2-10, and the dielectric substrate of the above 2nd is 5-50 as the characteristic feature.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the package possessing the antenna circuit while it contains the device for a RF especially microwave, or millimeter waves.
[0002]
[Description of the Prior Art] It continues till recent years, a development of the communication system using microwave and the millimeter wave etc. is performed briskly, and a development of the device for RFs used for those devices is being furthered.
[0003] Microwave and the millimeter wave are known for having properties, such as a wide band, a high resolution, and short wavelength. Since it has a merit, like the coherence to other communication system is small while a mass communication, a high-speed-data transmission, and the formation of small lightweight of a device are possible for these characteristic features, use to systems, such as ID card system, wireless LAN, and a mounted radar, is briskly developed from the former.
[0004] Such a system consists of the transmission line which usually connects the package and antenna which close RF devices, such as an antenna, a high-frequency oscillator, and amplifier, and a RF device, a RF device, or RF devices.
[0005] However, it is taken up as a problem that the output of the RF device [itself] is generally weak and that the loss in the transmission line is large. In order to reduce the transmission loss between an antenna and a RF device especially, the waveguide and coaxial cable with less transmission loss than the former are used as transmission line.
[0006]
[Problem(s) to be Solved by the Invention] However, conventionally, when the antenna and the RF device are prepared with another field and between these elements is connected with a waveguide or a coaxial cable, they have the problem that a system wide will become large, and have the trouble where it is not suitable for mass production.
[0007] On the other hand, as transmission line replaced with a waveguide or a coaxial cable, although the microstrip line, the coplanar waveguide, etc. are used, since the transmission loss per unit length had the fault of being large, compared with a waveguide or a coaxial cable, the present condition was being unable to use easily.
[0008] Therefore, in view of such status, this invention possesses an antenna element and a RF device, and aims at offering the usable package for RFs it being compact and suitable for the system using RFs, such as microwave which can moreover be mass-produced, or a millimeter wave.
[0009]
[Means for Solving the Problem] As a result of repeating a study to such a technical probrem, this invention persons approached as much as possible, have unified and arranged the RF device and the antenna, by shortening the length of the transmission line to which these are connected by a microstrip line, the coplanar waveguide, etc., found out that transmission loss could be reduced as much as possible, and resulted in this invention.
[0010] Namely, the antenna-circuit substrate in which the RF track for the package for RFs of this invention supplying electric power to an antenna element and this antenna element at the 1st dielectric substrate was formed, While the laminating unification of the RF device circuit board in which the transmission line for a mold cavity being formed in a part of 2nd dielectric substrate, and a RF device being contained in this mold cavity, and transmitting a signal to this RF device was formed is carried out It is characterized by connecting the RF track of the aforementioned antenna-circuit substrate, and the transmission line of the aforementioned RF device circuit board by the electromagnetic coupling.
[0011] Moreover, the aforementioned antenna-circuit substrate may be a lid for forming the aforementioned mold cavity in the aforementioned RF device circuit board, and it is still desirable that the specific inductive capacity of the dielectric substrate of the above 1st differs from the specific inductive capacity of the 2nd dielectric substrate.
[0012]
[Embodiments of the Invention] The structure of the package for RFs of this invention is explained on the basis of a drawing. Drawing 1 is a cross section showing an example of the package for RFs of this invention. In drawing 1 , the package for RFs 1 is constituted by RF device circuit board B with antenna-circuit substrate A. In antenna-circuit substrate A, the flat-surface type antenna element 3 is formed in the front face of the 1st dielectric substrate 2, and the RF track 4 (henceforth a feeder way) for supplying electric power to an antenna element 3 is formed in the field of the opposite side of antenna element 3 forming face of the dielectric substrate 2. Moreover, the grand layer 5 is mostly formed in the interior of the dielectric substrate 2 all over the inside of a substrate, and the slot 6 is formed in the position which counters with the antenna element 3 of this grand layer 5. the electromagnetic wave which was received by the antenna element 3 according to such antenna-circuit substrate A -- a slot 6 -- minding -- the feeder way 4 and electromagnetism -- it is combined-like and an electromagnetic wave is transmitted
[0013] On the other hand, a mold cavity 8 is formed in a part of 2nd dielectric substrate 7, the RF device 9 is contained in a mold cavity 8, and RF device circuit board B is airtightly closed with the lid 10. Moreover, the RF device 9 is electrically connected with the transmission line 11 formed in the 2nd dielectric substrate 7, and a signal is transmitted to the RF device 9 through the transmission line 11. Moreover, the grand layer 12 is formed also in the dielectric substrate 7 on the whole

surface.
[0014] Moreover, according to drawing 1 , by the tooth-back comrade of feeder way 4 forming face of the above-mentioned antenna-circuit substrate A, and RF device 9 forming face of RF device circuit board B, a laminating is carried out and it is unified. And between the feeder way 4 of antenna-circuit substrate A, and the transmission line 11 of RF device circuit board B, the grand layer 12 is formed in the whole surface, a slot 13 is formed in the grand layer 12 in the position where the feeder way 4 and the transmission line 11 counter, and the electromagnetic coupling of the feeder way 4 and the transmission line 11 is carried out through this slot 13.
[0015] Moreover, as for the grand layer 5 in antenna-circuit substrate A, and the grand layer 12 of RF device circuit board B, it is desirable to connect electrically by many Bahia halls 14 and 15 etc. as much as possible at the point of stopping the resonance phenomena of a grand layer.
[0016] Thus, although the electromagnetic coupling of the antenna element 3 in antenna-circuit substrate A, the feeder way 4 and the transmission line 11 in RF device circuit board B, and the feeder way 4 was carried out through the slots 6 and 13 formed in the grand layers 5 and 12 as each was mentioned above, they showed the electromagnetic-coupling structure of the transmission line 11 and the feeder way 4 in drawing 2 . It is formed so that it may become the impedance with same transmission line 11 and feeder way 4, and it is arranged so that those edges may see superficially and they may overlap by equivalents for one fourth of the length of the wavelength of a transmission signal. And in the grand layer of the duplication fraction, the slot 13 of the same width of face is mostly formed for width of face with the width of face of a track. Moreover, the length of this slot is formed in one half of the lengths of signal wave length.
[0017] Moreover, the electromagnetic coupling is carried out by arranging an antenna element 3 and the feeder way 4 like view 2 , and forming them.
[0018] according to the configuration of drawing 1 , the signal by the electromagnetic wave received by the antenna element 3 is transmitted to the feeder way 4 through a slot 6 -- having -- further -- the feeder way 4 and electromagnetism -- it is transmitted to the transmission line 11 combined-like, and, finally is transmitted to the RF device 9 In addition, after performing predetermined signal processing in the RF device 9, it is outputted by the external end-connection child 17 through the transmission line 16.
[0019] Drawing 3 is a cross section of other examples of the package for RFs of this invention. In drawing 3 , the same sign was attached about the same function part as the example of drawing 1 . According to such an example, the number of parts of the whole package can be decreased by forming as a lid (10) for forming the mold cavity [in RF device circuit board B for antenna-circuit substrate A] 8. Moreover, since the heat which joined the heat sink 18 to the RF device 9, and occurred from the RF device 9 can be made to radiate heat efficiently according to such a configuration, the malfunctioning by heating of a device can be prevented and the reliability of the function as a package can be raised further.
[0020] Usually, in an antenna circuit, when an antenna element 3 is a patch antenna as shown in drawings 1 and 3, the Q value of an antenna circuit has the property which becomes large in proportion to the specific inductive capacity of the 1st dielectric substrate, and becomes small in inverse proportion to thickness d of a dielectric substrate. When this Q value becomes small, since directivity is confused, the larger one of Q value is good. However, a frequency band will become narrow if Q value is too large. Here, if the dielectric constant of a dielectric substrate is enlarged not much in order to enlarge Q value, since the difference with the dielectric constant of air will become large, an electromagnetic wave becomes easy to spread a dielectric substrate front face, and becomes that it is hard to emanate to the space of orientation perpendicular to an antenna side. On the other hand, radiant efficiency is in the inclination which becomes large so that a dielectric constant is low and thickness d of a dielectric substrate is large.
[0021] Therefore, from such a viewpoint, in this invention, the specific inductive capacity of the 1st dielectric substrate 2 in antenna-circuit substrate A is suitable for 2-10, and the thickness (distance from the patch antenna 3 in drawing 1 to a slot 6) 0.03lambda0 to 0.06lambda0 (lambda 0 is the wavelength in a vacuum) of a dielectric substrate is also suitable. That is, specific inductive capacity is lower than 2, or thickness is 0.06lambda0. If thick, Q value will become small, specific inductive capacity is larger than 10, or thickness is 0.03lambda0. Radiant efficiency will become small if thin.
[0022] 50-300 micrometers is suitable for the line breadth of the transmission line 11 connected with the RF device 9 on the other hand, or the transmission line 16. This is because the circuit itself becomes large, when it is difficult to form a reliable track from printing technique, the yield at the time of a manufacture, etc. if line breadth is made smaller than 50 micrometers and it exceeds 300 micrometers. For this reason, 5-50 are suitable for the specific inductive capacity of the 2nd dielectric substrate 7 in a RF device circuit. For example, when specific inductive capacity is less than five in the case of a microstrip line, in order to set a characteristic impedance to 50 ohms, track width of face must be made larger than 300 micrometers, or dielectric thickness must be made smaller than 180 micrometers. thin for, as for the case of the former, the circuit itself becoming large, and mass-producing using tape multilayer technique in the case of the latter -- it elapses and is not suitable
[0023] On the other hand, if specific inductive capacity exceeds 50, in order to set a characteristic impedance to 50 ohms, track width of face must be made smaller than 50 micrometers, or dielectric thickness must be made larger than 700 micrometers. In the case of the former, it is difficult to form a reliable track, and when it is the latter, on the whole, the package itself becomes thick, and it is because it is not suitable.
[0024] According to the example of the drawing 1 and the drawing 3 , the dielectric substrate 2 in antenna-circuit substrate A It consists of the quality of the materials, such as an alumina ceramics, a crystallized glass, and an aluminium-nitride ceramics, from the above-mentioned viewpoint. an antenna element 3, the feeder way 4, and the grand layer 5 By conductor material, such as W, Mo, Cu, Au, and Ag, well-known multilayer technique, for example, the dielectric substrate 2 -- a crystallized glass, the feeder way 4, etc. -- copper -- the front face of the glass ceramic Plastic solid which constitutes a dielectric substrate when a conductor constitutes -- copper -- a conductor -- after printing and carrying out the laminating of the paste to a predetermined position, it can form by carrying out simultaneous baking
[0025] On the other hand, RF device circuit board B can also constitute the 1st the same quality of the material as the dielectric substrate 2, transmission line 12, and grand layer 16 for the dielectric substrate 7 from an above-mentioned viewpoint by the same conductors, such as the feeder way 4. What is necessary is just to form with the same multilayering technique as antenna-circuit substrate A also in this case. Then, the RF device 9 is installed with adhesives, such as an epoxy resin, a pewter, or an Au-Si alloy, in the mold cavity of the dielectric substrate 2.

[0026] In addition, desirably, when carrying out simultaneous baking with the conductor in a dielectric substrate and a substrate, respectively, after the aforementioned antenna-circuit substrate A and RF device circuit board B carry out the laminating unification of the Plastic solid before baking beforehand, it is desirable [B], although junction unification can also be carried out with desired adhesives, such as an Au-Si alloy and an Au-Sn alloy, to carry out simultaneous baking of antenna-circuit substrate A and the RF device circuit board B, and to form them.
[0027] In addition, according to the example of the drawing 1 and the drawing 3 , although an antenna element 3 is all a patch antenna, of course, it may be array-ized and may give directivity etc. Moreover, although it is possible to provide various functions in the RF device 9, it is desirable [the signal which possesses a low noise amplifier 21 and the amplifier 22 desirably including at least one frequency converter 19 and the high-frequency oscillator 20, and is outputted by the external end-connection child 17 of a package] to drop on a frequency lower than the signal frequency received or emitted by the antenna element 3, and to make transmission loss small like the configuration of drawing 4 , for example.
[0028]
[Effect of the Invention] Since according to the package for RFs of this invention the track which unifies an antenna-circuit substrate and the RF device circuit board, and is connected can be shortened and a loss in a track can be made into the minimum as explained above, though an antenna circuit is provided, it is small and the package for RFs applicable to the system using RFs, such as microwave which can moreover be mass-produced, or a millimeter wave, is obtained.

[Translation done.]

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Field

[The technical field to which invention belongs] this invention relates to the package possessing the antenna circuit while it contains the device for a RF especially microwave, or millimeter waves.

[Translation done.]

Technique

[Description of the Prior Art] It continues till recent years, a development of the communication system using microwave and the millimeter wave etc. is performed briskly, and a development of the device for RFs used for those devices is being furthered.

[0003] Microwave and the millimeter wave are known for having properties, such as a wide band, a high resolution, and short wavelength. Since it has a merit, like the coherence to other communication system is small while a mass communication, a high-speed-data transmission, and the formation of small lightweight of a device are possible for these characteristic features, use to systems, such as ID card system, wireless LAN, and a mounted radar, is briskly developed from the former.

[0004] Such a system consists of the transmission line which usually connects the package and antenna which close RF devices, such as an antenna, a high-frequency oscillator, and amplifier, and a RF device, a RF device, or RF devices.

[0005] However, it is taken up as a problem that the output of the RF device [itself] is generally weak and that the loss in the transmission line is large. In order to reduce the transmission loss between an antenna and a RF device especially, the waveguide and coaxial cable with less transmission loss than the former are used as transmission line.

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Effect

[Effect of the Invention] Since according to the package for RFs of this invention the track which unifies an antenna-circuit substrate and the RF device circuit board, and is connected can be shortened and a loss in a track can be made into the minimum as explained above, though an antenna circuit is provided, it is small and the package for RFs applicable to the system using RFs, such as microwave which can moreover be mass-produced, or a millimeter wave, is obtained.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, conventionally, when the antenna and the RF device are prepared with another field and between these elements is connected with a waveguide or a coaxial cable, they have the problem that a system wide will become large, and have the trouble where it is not suitable for mass production.
[0007] On the other hand, as transmission line replaced with a waveguide or a coaxial cable, although the microstrip line, the coplanar waveguide, etc. are used, since the transmission loss per unit length had the fault of being large, compared with a waveguide or a coaxial cable, the present condition was being unable to use easily.
[0008] Therefore, in view of such status, this invention possesses an antenna element and a RF device, and aims at offering the usable package for RFs it being compact and suitable for the system using RFs, such as microwave which can moreover be mass-produced, or a millimeter wave.

[Translation done.]

MEANS

[Means for Solving the Problem] As a result of repeating a study to such a technical probrem, this invention persons approached as much as possible, have unified and arranged the RF device and the antenna, by shortening the length of the transmission line to which these are connected by a microstrip line, the coplanar waveguide, etc., found out that transmission loss could be reduced as much as possible, and resulted in this invention.

[0010] Namely, the antenna-circuit substrate in which the RF track for the package for RFs of this invention supplying electric power to an antenna element and this antenna element at the 1st dielectric substrate was formed, While the laminating unification of the RF device circuit board in which the transmission line for a mold cavity being formed in a part of 2nd dielectric substrate, and a RF device being contained in this mold cavity, and transmitting a signal to this RF device was formed is carried out It is characterized by connecting the RF track of the aforementioned antenna-circuit substrate, and the transmission line of the aforementioned RF device circuit board by the electromagnetic coupling.

[0011] Moreover, the aforementioned antenna-circuit substrate may be a lid for forming the aforementioned mold cavity in the aforementioned RF device circuit board, and it is still desirable that the specific inductive capacity of the dielectric substrate of the above 1st differs from the specific inductive capacity of the 2nd dielectric substrate.

[0012]

[Embodiments of the Invention] The structure of the package for RFs of this invention is explained on the basis of a drawing. Drawing 1 is a cross section showing an example of the package for RFs of this invention. In drawing 1 , the package for RFs 1 is constituted by RF device circuit board B with antenna-circuit substrate A. In antenna-circuit substrate A, the flat-surface type antenna element 3 is formed in the front face of the 1st dielectric substrate 2, and the RF track 4 (henceforth a feeder way) for supplying electric power to an antenna element 3 is formed in the field of the opposite side of antenna element 3 forming face of the dielectric substrate 2. Moreover, the grand layer 5 is mostly formed in the interior of the dielectric substrate 2 all over the inside of a substrate, and the slot 6 is formed in the position which counters with the antenna element 3 of this grand layer 5. the electromagnetic wave which was received by the antenna element 3 according to such antenna-circuit substrate A -- a slot 6 -- minding -- the feeder way 4 and electromagnetism -- it is combined-like and an electromagnetic wave is transmitted

[0013] On the other hand, a mold cavity 8 is formed in a part of 2nd dielectric substrate 7, the RF device 9 is contained in a mold cavity 8, and RF device circuit board B is airtightly closed with the lid 10. Moreover, the RF device 9 is electrically connected with the transmission line 11 formed in the 2nd dielectric substrate 7, and a signal is transmitted to the RF device 9 through the transmission line 11. Moreover, the grand layer 12 is formed also in the dielectric substrate 7 on the whole surface.

[0014] Moreover, according to drawing 1 , by the tooth-back comrade of feeder way 4 forming face of the above-mentioned antenna-circuit substrate A, and RF device 9 forming face of RF device circuit board B, a laminating is carried out and it is unified. And between the feeder way 4 of antenna-circuit substrate A, and the transmission line 11 of RF device circuit board B, the grand layer 12 is formed in the whole surface, a slot 13 is formed in the grand layer 12 in the position where the feeder way 4 and the transmission line 11 counter, and the electromagnetic coupling of the feeder way 4 and the transmission line 11 is carried out through this slot 13.

[0015] Moreover, as for the grand layer 5 in antenna-circuit substrate A, and the grand layer 12 of RF device circuit board B, it is desirable to connect electrically by many Bahia halls 14 and 15 etc. as much as possible at the point of stopping the resonance phenomena of a grand layer.

[0016] Thus, although the electromagnetic coupling of the antenna element 3 in antenna-circuit substrate A, the feeder way 4 and the transmission line 11 in RF device circuit board B, and the feeder way 4 was carried out through the slots 6 and 13 formed in the grand layers 5 and 12 as each was mentioned above, they showed the electromagnetic-coupling structure of the transmission line 11 and the feeder way 4 in drawing 2 . It is formed so that it may become the impedance with same transmission line 11 and feeder way 4, and it is arranged so that those edges may see superficially and they may overlap by equivalents for one fourth of the length of the wavelength of a transmission signal. And in the grand layer of the duplication fraction, the slot 13 of the same width of face is mostly formed for width of face with the width of face of a track. Moreover, the length of this slot is formed in one half of the lengths of signal wave length.

[0017] Moreover, the electromagnetic coupling is carried out by arranging an antenna element 3 and the feeder way 4 like view 2 , and forming them.

[0018] according to the configuration of drawing 1 , the signal by the electromagnetic wave received by the antenna element 3 is transmitted to the feeder way 4 through a slot 6 -- having -- further -- the feeder way 4 and electromagnetism -- it is transmitted to the transmission line 11 combined-like, and, finally is transmitted to the RF device 9 In addition, after performing predetermined signal processing in the RF device 9, it is outputted by the external end-connection child 17 through the transmission line 16.

[0019] Drawing 3 is a cross section of other examples of the package for RFs of this invention. In drawing 3 , the same sign was attached about the same function part as the example of drawing 1 . According to such an example, the number of parts of the whole package can be decreased by forming as a lid (10) for forming the mold cavity [in RF device circuit board B for antenna-circuit substrate A] 8. Moreover, since the heat which joined the heat sink 18 to the RF device 9, and occurred

from the RF device 9 can be made to radiate heat efficiently according to such a configuration, the malfunctioning by heating of a device can be prevented and the reliability of the function as a package can be raised further.
[0020] Usually, in an antenna circuit, when an antenna element 3 is a patch antenna as shown in drawings 1 and 3, the Q value of an antenna circuit has the property which becomes large in proportion to the specific inductive capacity of the 1st dielectric substrate, and becomes small in inverse proportion to thickness d of a dielectric substrate. When this Q value becomes small, since directivity is confused, the larger one of Q value is good. However, a frequency band will become narrow if Q value is too large. Here, if the dielectric constant of a dielectric substrate is enlarged not much in order to enlarge Q value, since the difference with the dielectric constant of air will become large, an electromagnetic wave becomes easy to spread a dielectric substrate front face, and becomes that it is hard to emanate to the space of orientation perpendicular to an antenna side. On the other hand, radiant efficiency is in the inclination which becomes large so that a dielectric constant is low and thickness d of a dielectric substrate is large.
[0021] Therefore, from such a viewpoint, in this invention, the specific inductive capacity of the 1st dielectric substrate 2 in antenna-circuit substrate A is suitable for 2-10, and the thickness (distance from the patch antenna 3 in drawing 1 to a slot 6) 0.03lambda0 to 0.06lambda0 (lambda 0 is the wavelength in a vacuum) of a dielectric substrate is also suitable. That is, specific inductive capacity is lower than 2, or thickness is 0.06lambda0. If thick, Q value will become small, specific inductive capacity is larger than 10, or thickness is 0.03lambda0. Radiant efficiency will become small if thin.
[0022] 50-300 micrometers is suitable for the line breadth of the transmission line 11 connected with the RF device 9 on the other hand, or the transmission line 16. This is because the circuit itself becomes large, when it is difficult to form a reliable track from printing technique, the yield at the time of a manufacture, etc. if line breadth is made smaller than 50 micrometers and it exceeds 300 micrometers. For this reason, 5-50 are suitable for the specific inductive capacity of the 2nd dielectric substrate 7 in a RF device circuit. For example, when specific inductive capacity is less than five in the case of a microstrip line, in order to set a characteristic impedance to 50 ohms, track width of face must be made larger than 300 micrometers, or dielectric thickness must be made smaller than 180 micrometers. thin for, as for the case of the former, the circuit itself becoming large, and mass-producing using tape multilayer technique in the case of the latter -- it elapses and is not suitable
[0023] On the other hand, if specific inductive capacity exceeds 50, in order to set a characteristic impedance to 50 ohms, track width of face must be made smaller than 50 micrometers, or dielectric thickness must be made larger than 700 micrometers. In the case of the former, it is difficult to form a reliable track, and when it is the latter, on the whole, the package itself becomes thick, and it is because it is not suitable.
[0024] According to the example of the drawing 1 and the drawing 3 , the dielectric substrate 2 in antenna-circuit substrate A It consists of the quality of the materials, such as an alumina ceramics, a crystallized glass, and an aluminium-nitride ceramics, from the above-mentioned viewpoint. an antenna element 3, the feeder way 4, and the grand layer 5 By conductor material, such as W, Mo, Cu, Au, and Ag, well-known multilayer technique, for example, the dielectric substrate 2 -- a crystallized glass, the feeder way 4, etc. -- copper -- the front face of the glass ceramic Plastic solid which constitutes a dielectric substrate when a conductor constitutes -- copper -- a conductor -- after printing and carrying out the laminating of the paste to a predetermined position, it can form by carrying out simultaneous baking
[0025] On the other hand, RF device circuit board B can also constitute the 1st the same quality of the material as the dielectric substrate 2, transmission line 12, and grand layer 16 for the dielectric substrate 7 from an above-mentioned viewpoint by the same conductors, such as the feeder way 4. What is necessary is just to form with the same multilayering technique as antenna-circuit substrate A also in this case. Then, the RF device 9 is installed with adhesives, such as an epoxy resin, a pewter, or an Au-Si alloy, in the mold cavity of the dielectric substrate 2.
[0026] In addition, desirably, when carrying out simultaneous baking with the conductor in a dielectric substrate and a substrate, respectively, after the aforementioned antenna-circuit substrate A and RF device circuit board B carry out the laminating unification of the Plastic solid before baking beforehand, it is desirable [B], although junction unification can also be carried out with desired adhesives, such as an Au-Si alloy and an Au-Sn alloy, to carry out simultaneous baking of antenna-circuit substrate A and the RF device circuit board B, and to form them.
[0027] In addition, according to the example of the drawing 1 and the drawing 3 , although an antenna element 3 is all a patch antenna, of course, it may be array-ized and may give directivity etc. Moreover, although it is possible to provide various functions in the RF device 9, it is desirable [the signal which possesses a low noise amplifier 21 and the amplifier 22 desirably including at least one frequency converter 19 and the high-frequency oscillator 20, and is outputted by the external end-connection child 17 of a package] to drop on a frequency lower than the signal frequency received or emitted by the antenna element 3, and to make transmission loss small like the configuration of drawing 4 , for example.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

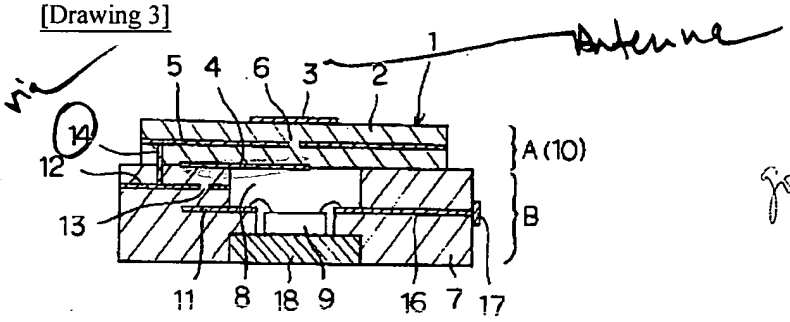
[Brief Description of the Drawings]
[Drawing 1] It is the cross section showing one example of the fundamental structure of the package for RFs of this invention.
[Drawing 2] It is drawing for explaining the electromagnetic-coupling structure in the package of drawing 1 , and (a) is a plan and (b) is a cross section.
[Drawing 3] It is the cross section showing other examples of the fundamental structure of the package for RFs of this invention.
[Drawing 4] It is the block diagram showing an example of the RF device contained in the package for RFs of this invention.

[Description of Notations]
1 Package for RFs
A Antenna-circuit substrate
B RF device circuit board
2 1st Dielectric Substrate
3 Antenna Element
4 RF Track
5 Grand Layer
6 Slot
7 2nd Dielectric Substrate
8 Mold Cavity
9 RF Device
10 Lid
11 Transmission Line
12 Grand Layer
13 Slot
14, 15 Bahia hall
16 Transmission Line
17 External End-Connection Child

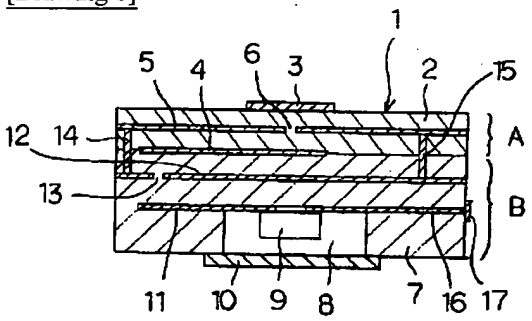
[Translation done.]

DRAWINGS

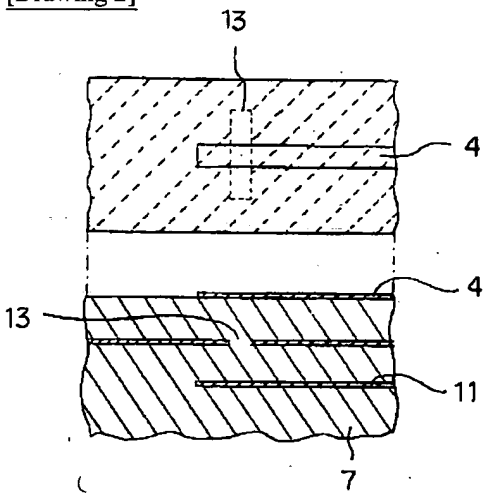
[Drawing 3]



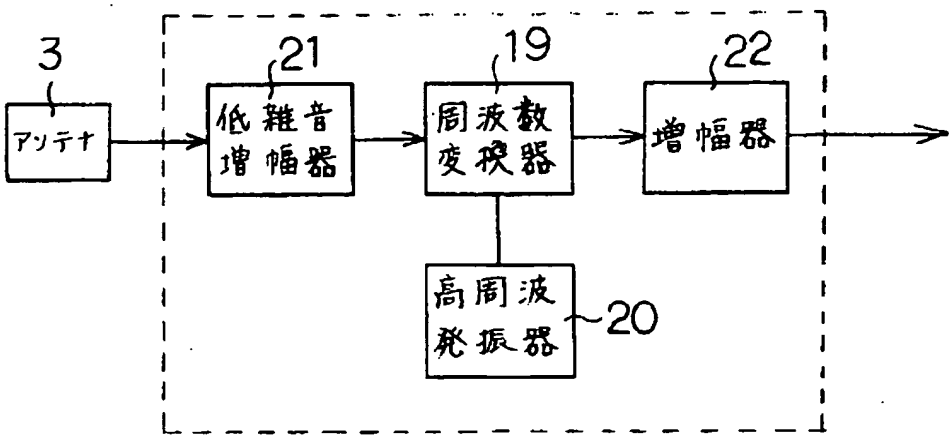
[Drawing 1]



[Drawing 2]



[Drawing 4]



[Translation done.]